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Protecting Health and Safety at Hazardous Waste Sites: An Overview

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Protecting Health and Safety at Hazardous Waste Sites: An Overview

September 1985

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Contents

1. Introduction 1
2. Hazards 2
3. Planning 4
4. Training 9
5. Medical Monitoring 13
6. Site Characterization 16
7. Personal Protective Equipment 19
8. Site Control 28
9. Decontamination 32
10. Handling Drums and Other Containers 35
11. Site Emergencies 39

1. Introduction

Improper disposal of commercial, industrial and municipal hazardous wastes over the past several decades has produced thousands of sites where groundwater, surface water, soil and/or air are contaminated with chemicals. The environmental and potential human health consequences of improper disposal of hazardous wastes have been demonstrated by episodes such as New York's Love Canal and Kentucky's Valley of the Drums. In response to the health and environmental impacts of improper waste disposal, Congress enacted the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) of 1980, which provided for "liability, compensation, cleanup, and emergency response for hazardous substances released into the environment."

Cleanup operations at inactive hazardous waste sites are now underway throughout the country. Thousands of workers are involved in this national effort. Because of the potential hazards inherent in such operations, an interagency committee, consisting of the National Institute for Occupational Safety and Health ([NIOSH] the lead agency), the U.S. Environmental Protection Agency (EPA), the Occupational Safety and Health Administration (OSHA), and the U.S. Coast Guard (USCG), has developed guidelines for protecting worker health and safety at inactive hazardous waste sites.

This booklet summarizes those guidelines and presents key issues to consider in designing, implementing, or evaluating a health and safety program for work at inactive hazardous waste sites. Much of the information is also relevant to planning for response to emergencies involving hazardous substances.

This booklet is geared for nontechnical personnel. Individuals who are directly responsible for designing, implementing, or evaluating occupational safety and health programs at inactive hazardous waste sites should refer to the more detailed guidance document entitled *Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities* (DHHS/NIOSH Publication No. 85-115), available from the National Institute for Occupational Safety and Health, Cincinnati, Ohio. In addition, the appropriate Federal, state, and local agencies should be contacted for assistance and guidance.

Responsiveness to site conditions is a frequent theme throughout this document. To be maximally effective, a health and safety program must be tailored to the unique conditions at each site, not only initially, but also throughout a project in response to changing site conditions and new information. Thus periodic review, reassessment and redefinition of a health and safety program must take place at a managerial level, and site workers and their supervisors must be continually alert for new conditions that suggest a need for change. Awareness and responsiveness are, therefore, key attitudes needed to ensure an effective health and safety program.

The protection of health and safety at a hazardous waste site extends far beyond individual actions such as the modification of work practices or the use of specialized equipment. It must be integrated into all aspects of site operations, and must be a conscious priority for all involved—from corporate management to the most recently hired field employees. This booklet introduces the building blocks of an effective health and safety program.

2. Hazards

Hazardous waste sites pose numerous health and safety concerns, any one of which could result in serious injury or death. Several factors distinguish the hazardous waste site environment from other occupational situations involving hazardous substances:

- A large number and variety of substances may be present.
- The identity of the substances is often unknown.
- The substances have not been properly handled and controlled.
- The physical environment may be dangerous.
- Working in protective clothing can cause significant stress.

The combination of these conditions results in hazards that may pose an immediate danger to life or health; may not be immediately obvious or identifiable; and may change as the onsite work location and cleanup activities vary. Potential hazards include:

- *Chemical exposure.* Chemical substances can cause toxic effects by entering the unprotected human body through inhalation, skin absorption, ingestion, or puncture wounds. Toxic effects may be temporary and reversible (e.g., dizziness, nausea), or permanent (e.g., disability, organ damage, or death). They may be immediately apparent, or take months or even years to manifest without any initial warning signs.
- *Fire and explosion.* Although fires and explosions may occur spontaneously at a site, more often they are caused by investigative or remedial activities, such as moving drums, mixing incompatible chemicals, or introducing an ignition source (e.g., sparks from equipment) into an explosive or flammable environment. In addition to creating hazards because of intense heat and smoke, open flames, and flying objects, a fire may also cause the release of toxic chemicals.
- *Oxygen deficiency.* Oxygen deficiency may result from the displacement of oxygen by another gas or the consumption of oxygen in a chemical reaction. Confined spaces or low-lying areas are particularly vulnerable to oxygen deficiency. The physiological effects of oxygen deficiency include impaired attention, judgment and coordination, and increased breathing and heart rate. Extreme oxygen deficiency may result in nausea, brain damage, heart damage, unconsciousness, and death. At hazardous waste sites, less than 19.5 percent oxygen (at sea level) is considered indicative of oxygen deficiency.
- *Ionizing radiation.* Radioactive materials at a site commonly emit one or more of three types of harmful radiation: alpha, beta, or gamma. Penetration by alpha radiation is usually stopped by clothing and the outer layers of the skin, but alpha-emitting materials can be hazardous if inhaled or ingested. Beta radiation can cause harmful "beta burns" to the skin and can damage subsurface blood vessels. Beta-emitting materials are hazardous if inhaled or ingested. Use of protective clothing, coupled with scrupulous personal hygiene and decontamination, affords good protection against alpha and beta radiation. Gamma radiation can cause serious permanent damage to the body because it easily passes through protective clothing and human tissue. If levels of radiation above natural background are discovered, site activities should cease until the site has been assessed by health physicists.

- *Biological hazards.* Wastes from hospitals and research facilities may contain disease-causing organisms that could infect site personnel. In addition, poisonous plants, insects, animals and indigenous pathogens are other biological hazards which may be present.
- *Safety hazards.* Holes or ditches, sharp objects, slippery surfaces, steep grades, unstable surfaces, and precariously positioned objects can create safety hazards for waste site workers. Use of personal protective equipment (PPE) and heavy machinery may also increase the risk of accidents by impairing workers' agility, hearing, and vision.
- *Electrical hazards.* Overhead power lines, downed electrical wires, buried cables, and electrical equipment may pose a danger of shock or electrocution.
- *Heat stress.* Heat stress is a major hazard, especially for workers wearing protective clothing. Depending on the ambient conditions and the work being performed, heat stress can occur very rapidly—within as little as 15 minutes. Symptoms include rashes, drowsiness, and cramps. Heat stress may lead to heat stroke and death.
- *Cold exposure.* Cold injury (frostbite and hypothermia) and impaired ability to work are dangers at low temperatures and when the wind-chill factor is low.
- *Noise.* Heavy equipment used in cleanup operations may startle, annoy or distract workers, may cause temporary and/or permanent hearing loss, and may interfere with communication.

A health and safety program for hazardous waste site activities must protect against all known and potential hazards. Of particular concern are inhalation hazards that may pose an immediate danger to life or health (IDLH) and any other conditions that may cause death or serious harm (see Table 1). Protection from these conditions is a top priority.

Determining, through information gathering, inspection and monitoring, which hazards are present is one of the first steps in hazardous waste site activities (see *6. Site Characterization*). Based on this information, specific resources can be obtained and procedures developed to protect personnel.

Table 1. Visible Indicators of Potential IDLH[a] and Other Dangerous Conditions

- Large containers or tanks that must be entered.
- Enclosed spaces such as buildings or trenches that must be entered.
- Potentially explosive or flammable situations (indicated by bulging drums, effervescence, gas generation, or instrument readings).
- Extremely hazardous materials (such as cyanide, phosgene, or radiation sources).
- Visible vapor clouds.
- Areas where biological indicators (such as dead animals or vegetation) are located.

[a]IDLH = Inhalation hazards that are immediately dangerous to life or health.

3. Planning

Planning is the cornerstone of prevention. By anticipating and taking steps to minimize potential hazards to health and safety, work at hazardous waste sites can proceed with minimum risk to workers and the public. To accomplish this, three plans should be developed:

- *A Work Plan* that considers each specific phase of investigation and response. The Work Plan establishes the objectives of site operations and the logistics and resources required to achieve them. It should include an organizational structure that identifies the personnel needed for the overall operation, establishes the chain-of-command, and specifies the responsibilities of each employee. Preparation of the Work Plan may require input from all levels of onsite and offsite management.
- *A Site Safety Plan* that identifies the safety and health hazards of each phase of operation and defines the requirements and procedures for protecting workers and the public (see Insert). This plan should be developed by senior-level offsite and onsite management and reviewed by occupational and industrial health and safety experts.
- *A Contingency Plan* for handling emergencies that may occur on site. The Contingency Plan should set forth training requirements, personnel roles, communication systems, site security and control, decontamination procedures, step-by-step emergency

SITE SAFETY PLAN

The Site Safety Plan establishes policies and procedures to protect workers and the public from the potential hazards posed by work at a hazardous waste site. The Site Safety Plan should be developed before site activities proceed and should be modified as needed for every stage of site activity. At a minimum, the plan should:

- Name key personnel and alternates responsible for site safety.
- Describe the risks associated with each operation conducted.
- Confirm that personnel are adequately trained to perform their job responsibilities and to handle the specific hazardous situations they may encounter.
- Describe the protective clothing and equipment to be worn by personnel during various site operations.
- Describe any site-specific medical surveillance requirements.
- Describe the program for periodic air monitoring, personnel monitoring, and environmental sampling, if needed.
- Describe the actions to be taken to mitigate existing hazards (e.g., containment of contaminated materials) to make the work environment less hazardous.
- Define site control measures and include a site map.
- Establish decontamination procedures for personnel and equipment.
- Set forth the site's standard operating procedures (SOPs). SOPs are those activities that can be standardized (such as decontamination and respirator fit testing), and where a checklist can be used.
- Set forth a Contingency Plan for safe and effective response to emergencies.

response procedures, evacuat on routes, and documentation ar d reporting responsibilities in the event of an emergency. It should also specify the procedures for contacting and coordinating with the existing local, state and Federal response community during an emergency. The Contingency Plan is generally a separate section within the Site Safety Plan.

ONGOING PROCESS

Planning must be viewed as an ongoing process, since site conditions constantly change. All three plans must be continually adapted to new site conditions and new information. Safety meetings should be held prior to initiating any site activity and before and after each work day to review important aspects of the Work Plan and Site Safety Plan, to describe any changes, and to receive worker feedback. In addition, the Site Safety Officer (see Insert) should conduct frequent inspections to determine whether the plans are adequate and being followed.

PERSONNEL ORGANIZATION

Figure 1 shows a generalized approach to personnel organization for hazardous waste site investigation and response at a large site. For smaller efforts, single individuals may assume several roles. Regardless of the size of the effort, all response teams should include a Site Safety Officer responsible for implementing health and safety requirements. The Site Safety Officer should have ready access to other occupa-

SITE SAFETY OFFICER

The Site Safety Officer is a key individual in the protection of health and safety at hazardous waste sites. He or she advises the Project Team Leader on all aspects of health and safety on site and recommends stopping work if any operation threatens worker or public health or safety. The Site Safety Officer's responsibilities include:

- Selecting protective clothing and equipment.
- Periodically inspecting protective clothing and equipment.
- Ensuring that protective clothing and equipment are properly stored and maintained.
- Controlling entry to and exit from the contaminated areas or zones of a site.
- Confirming each team member's suitability for work based on a physician's recommendation.
- Monitoring the work parties for signs of stress, such as cold exposure, heat stress, and fatigue.
- Monitoring onsite hazards and conditions.
- Participating in the development of and implementing the Site Safety Plan.
- Conducting periodic inspections to determine if the Site Safety Plan is being followed.
- Knowing (and ensuring that all site personnel also know) emergency procedures, evacuation routes, and the telephone numbers of the ambulance, local hospital, poison control center, fire department, and police department.
- Notifying, when necessary, local public emergency officials.
- Coordinating emergency medical care.

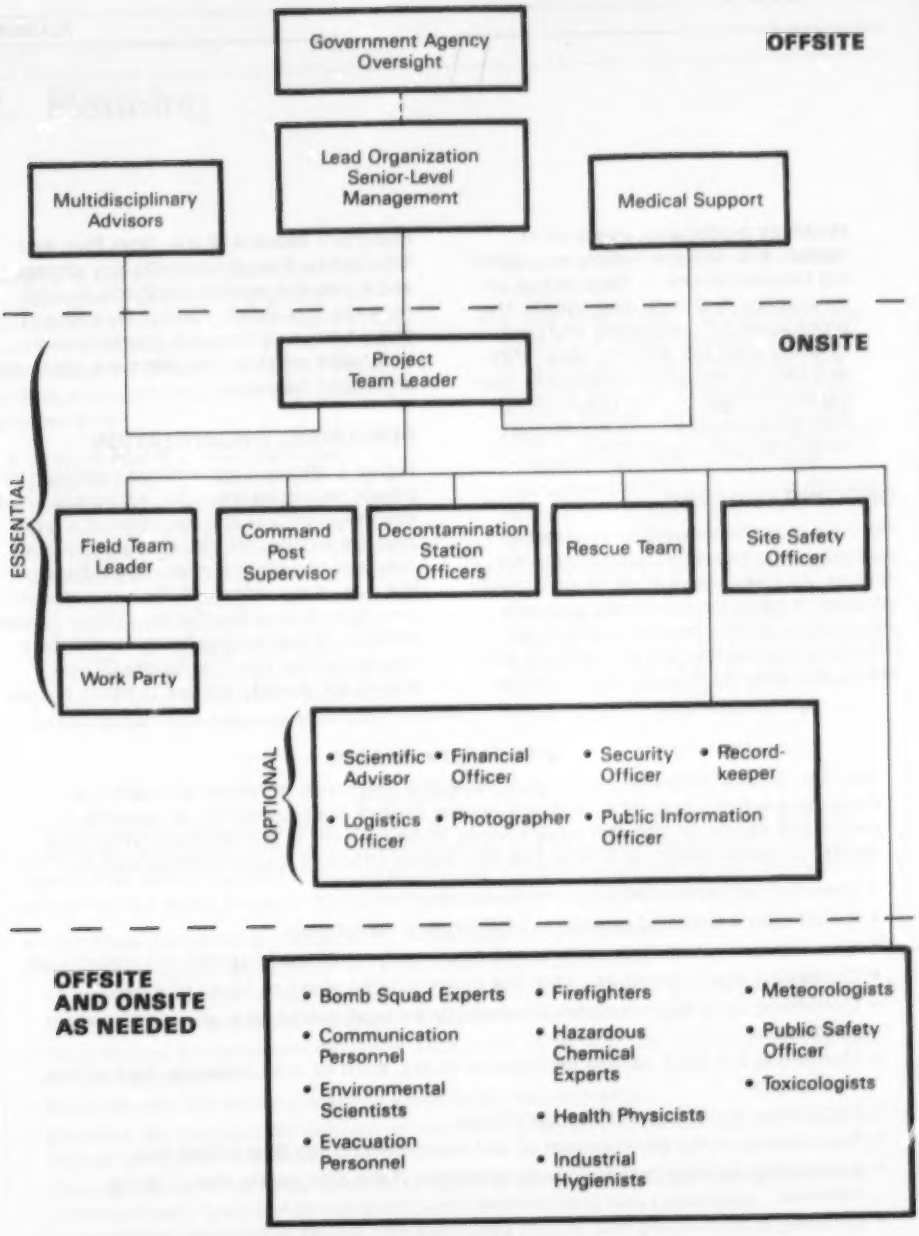


Figure 1. Generalized Approach to Personnel Organization for Site Investigation and Response

tional health and safety professionals with specialized expertise as needed.

PROTECTING THE PUBLIC

The effective management of response actions at hazardous waste sites requires a commitment to the health and safety of the general public as well as to the onsite personnel. Onsite containment and prevention of contaminant release into the surrounding community should be addressed in the planning stages of a project. Not only must the public be protected, they must also be made aware of the health and safety program and have confidence in it. To accomplish these goals, the Project Team Leader (see Insert), or Public Information Officer under the supervision of the Project Team Leader, should establish community liaison well before any response action is begun, and should maintain continual contact with community leaders.

MANAGEMENT OBJECTIVES

One of the most critical elements in worker safety is the attitude of all levels of project management. A strong and visible commitment to worker safety must be present from the beginning of a project. This initial attitude sets the tone for the entire operation. The Site Safety Officer and the Project Team Leader must have the clear support of senior-level management for establishing, implementing, and enforcing safety programs from the outset of the project. The importance of management's attitude toward safety throughout the project cannot be overemphasized; site personnel are more likely to cooperate with safety programs if they sense a genuine concern on the part of management.

Several other organizational factors are indicators of successful worker safety programs. These factors include:

PROJECT TEAM LEADER

The Project Team Leader is in charge of all onsite activities and has the authority to direct investigation and response operations. The Project Team Leader's responsibilities include:

- Managing the development of the Work Plan and Site Safety Plan.
- Obtaining permission for site access and coordinating activities with appropriate officials.
- Supervising workers in the field and briefing them on their specific assignments.
- Coordinating with the Site Safety Officer to ensure that health and safety requirements are met.
- Ensuring that the Work Plan is completed and on schedule.
- Preparing the final report and support files on the response activities.
- Serving as the liaison with public officials.

- Close contact and interaction among workers, supervisors, and management enabling open communications on safety as well as other job-related matters.
- A high level of housekeeping, orderly workplace conditions, and effective environmental quality control.
- Well-developed selection, job placement, and advancement procedures plus other employee support services.
- Training practices emphasizing early indoctrination and followup instruction in job safety procedures.
- Added features or variations in conventional safety practices that enhance the effectiveness of those practices.
- An effective disciplinary plan to encourage employees to adhere to safety practices.

Overall, the most effective industrial safety programs are successful in dealing with "people" variables. Thus, translation of a plan from written procedures to action is as critical as the initial development of the plan.

4. Training

Like planning, training provides the foundation upon which all other protective measures depend. Because of the potential hazards at hazardous waste sites, anyone entering a site, including visitors, must receive sufficient training to understand the hazards and utilize any necessary protective measures.

CLEANUP PERSONNEL

Personnel actively involved in site cleanup must be thoroughly familiar with programs and procedures contained in the Site Safety Plan and must be trained to work in contaminated areas. The level of training should be consistent with the worker's job function and responsibilities. The training program should involve both classroom instruction in a wide range of health and safety topics and "hands-on" practice in equipment handling and operational procedures. In the classroom, a variety of teaching aids (i.e., films, slides, etc.) should be used. Hands-on instruction should consist of field drills that simulate site activities and conditions. The training program should also include onsite experience under the direct supervision of trained, experienced personnel. Table 2 describes the types of training that site personnel and visitors should receive.

SITE WORKERS

General site workers, such as equipment operators, general laborers, technicians, and other supervised personnel, should attend training sessions that apply to their individual jobs and responsibilities, as well as training sessions that provide an overview of the site hazards and the means of controlling those hazards. Depending on their individual jobs, worker training should include classroom instruction in the following areas:

- Site Safety Plan.
- Safe work practices.

The training program should involve field drills that simulate emergency situations. Here workers wearing Level A personal protective equipment (see Table 4) repair a leaking pipe as part of a training exercise.

- Nature of the anticipated hazards.
- Handling emergencies and self-rescue.
- Rules and regulations for vehicle use.
- Safe use of field equipment.
- Handling, storage, and transportation of hazardous materials.
- Use and care of personal protective clothing and equipment.
- Safe sampling techniques.
- Employee rights and responsibilities.

In addition to classroom instruction, general site workers should engage in actual field activities under the direct supervision of a trained, experienced supervisor.

Table 2. Recommended Training by Job Category[a]

TRAINING TOPIC	EMPHASIS OF TRAINING	GENERAL SITE WORKER	ONSITE MANAGEMENT AND SUPERVISORS	HEALTH AND SAFETY STAFF	VISITOR
Biology, Chemistry, and Physics of Hazardous Materials	Chemical and physical properties; chemical reactions; chemical compatibilities.	R	R	R	
Toxicology	Dosage, routes of exposure, toxic effects, immediately dangerous to life or health (IDLH) values, permissible exposure limits (PELs), recommended exposure limits (RELs), threshold limit values (TLVs).	R	R	R	
Industrial Hygiene	Selection and monitoring of personal protective clothing and equipment.		R	R	
	Calculation of doses and exposure levels; evaluation of hazards; selection of worker health and safety protective measures.		R	R	
Rights and Responsibilities of Workers Under OSHA	Applicable provisions of Title 29 of the Code of Federal Regulations (the OSH Act).	R	R	R	
Monitoring Equipment	Functions, capabilities, selection, use, limitations, and maintenance.	R	R	R	
Hazard Evaluation	Techniques of sampling and assessment.		R	R	
	Evaluation of field and lab results.		R	R	
	Risk assessment.		O	R	
Site Safety Plan	Safe practices, safety briefings and meetings, standard operating procedures, site safety map.	R	R	R	R
Standard Operating Procedures (SOPs)	Hands-on practice.	R	R	R	
	Development and compliance.		R	R	

[a]R = Recommended. O = Optional.

Table 2 (Cont.)

TRAINING TOPIC	EMPHASIS OF TRAINING	GENERAL SITE WORKER	ONSITE MANAGEMENT AND SUPERVISORS	HEALTH AND SAFETY STAFF	VISITORS
Engineering Controls	The use of barriers, isolation, and distance to minimize hazards.	R	R	R	
Personal Protective Clothing and Equipment (PPE)	Assignment, sizing, fit-testing, maintenance, use, limitations, and hands-on training.	R	R	R	R
	Selection of PPE.		O	R	
	Ergonomics.			R	
Medical Program	Medical monitoring, first aid, stress recognition.	R	R	R	
	Advanced first aid, cardio-pulmonary resuscitation (CPR); emergency drills.	O	R	R	
	Design, planning, and implementation.			R	
Decontamination	Hands-on training using simulated field conditions.	R	R	R	
	Design and maintenance.	R	R	R	
Legal and Regulatory Aspects	Applicable safety and health regulations (OSHA, EPA, etc.).	O	R	R	
Emergencies	Emergency help and self-rescue; emergency drills.	R	R	R	
	Response to emergencies; follow-up investigation and documentation.		R	R	

Workers who may be exposed to unique hazards or who may occasionally supervise others should receive additional training in areas such as safe use of specialized monitoring and protective equipment, decontamination, etc.

ONSITE MANAGEMENT AND SUPERVISORS

Onsite management and supervisors, such as Project Team Leaders, who are responsible for directing others should receive the same training as the general site workers for whom they are responsible, as well as additional training to enhance their ability to provide guidance and make informed

decisions. This additional training should include management of hazardous waste site cleanup operations, management of the site work zones (see *8. Site Control*), and how to communicate with the press and local community.

HEALTH AND SAFETY STAFF

Health and safety staff with specific responsibilities for health and safety guidance on site, such as Site Safety Officers, should be familiar with the training provided to general site workers and their supervisors, and should receive advanced training in health and safety issues, policies, and techniques.

VISITORS

Visitors to the site (including elected and appointed officials, media representatives, senior-level management, and others) must also receive a briefing on the Site Safety Plan and applicable emergency procedures. These visitors should not be permitted in the contaminated area of the site unless they have been trained, fit-tested, and medically approved for respirator use. All other visitors should observe site conditions from the site's clean areas using binoculars.

TRAINING PROGRAM

All training information should be presented in clear, concise language. Particularly important information, such as the site's standard operating procedures, should be provided to each employee in writing. All employees should complete refresher training at least annually to reemphasize the initial training, to maintain proficiency in the safe use of equipment, and to update employees on any new policies or procedures. A record of training should be maintained in each employee's personnel file to confirm that every person assigned to a task has had adequate training for that task, and that every employee's training is up to date.

5. Medical Monitoring

Workers handling hazardous wastes can experience high levels of stress. Their daily tasks may expose them to toxic chemicals, biological hazards, radiation, and safety hazards; they may be required to perform strenuous tasks under physically stressful conditions; and they may have to face life-threatening situations and emergencies. A medical program is essential to assess and monitor workers' health and fitness, to determine the adequacy of worker protection, to provide emergency and other treatment as needed, and to keep accurate records for future reference. In addition, OSHA recommends a medical evaluation for employees required to wear a respirator (29 CFR Part 1910.134[b][10]), and certain OSHA standards include specific medical requirements (29 CFR Part 1910.95 and 1910.1001 through 1910.1045) for worker protection. Information from a site medical program may also be used to conduct future epidemiological studies; to adjudicate claims; to provide evidence in litigation; and to report workers' medical conditions to Federal, state, and local agencies, as required by law.

PROGRAM MANAGEMENT

A medical program should be developed for each site based on the specific location, needs, and potential exposures of employees at the site. The program should be designed by an experienced occupational health physician or other qualified occupational health consultant in conjunction with the Site Safety Officer. The director of a site medical program should be the responsibility of a physician who is board-certified in occupational medicine or a medical doctor who has had extensive experience managing occupational health services. Where necessary, the site medical program may be managed, and relevant examinations performed, by a local physician with assistance from an occupational medicine consultant. These functions may also be performed by a qualified Registered Nurse, preferably an Occupational Health Nurse, under the direction of a suitably qualified physician who has responsibility for the program. (Certified, state-licensed [where required] Physician's Assistants may also perform these examinations if a physician is available on the premises.)

CONTENT

A hazardous waste site medical program should include the following components:

- Surveillance, consisting of:
  - *Pre-employment screening* to determine an individual's fitness for duty. Screening should include an occupational and medical history, physical examination, and tests to determine a person's ability to work while wearing protective equipment. Pre-employment screening can also be used to provide baseline data for comparison with future medical data.
  - *Periodic medical examinations* (and followup examinations when appropriate). Periodic examinations may resemble the pre-employment examination with modifications based on current conditions, such as changes in site hazards, exposures, or any symptoms exhibited by a worker. The frequency and content of examinations will vary, depending on the nature of the work and the exposures. Generally, annual medical examinations are recommended. More frequent surveillance may be necessary depending on the extent of potential or actual exposure, the chemicals involved, the duration of the work assignment, and the individual worker.

  - *A termination examination.* All employees should have a medical examination at the end of their employment. This may be limited to an interval medical history of the period since the last full examination if (1) the last full examination was within the last 6 months, (2) no exposure occurred in that time, and (3) no symptoms of exposure occurred in that time. Otherwise, a full physical examination and appropriate laboratory diagnostic tests (if necessary) should be conducted.
- *Treatment*, both emergency and non-emergency as needed.
- *Recordkeeping.* Proper recordkeeping is essential at hazardous waste sites because of the nature of the work and risks: employees may work at a large number of geographically separate sites during their careers, and adverse effects of long-term exposure may not become apparent for many years. Records enable subsequent medical care providers to be informed about workers' previous and current exposures.
- *Program review and evaluation* to ensure the medical program's effectiveness and to update medical tests and treatments. Review should be performed by the Site Safety Officer, medical consultant, and/or management representative at least annually.

Table 3 outlines some key components of a recommended medical program for hazardous waste sites.

EFFECTIVENESS

The effectiveness of a medical program depends on active worker involvement. In addition, management should have a firm commitment to worker health and safety, and is encouraged to express this commitment not only by providing medical surveillance and treatment, but also through management directives and informal encouragement of employees to maintain good health through exercise, proper diet, and avoidance of tobacco, alcohol abuse and drug abuse. In particular, management should:

- Urge prospective employees to provide a complete and detailed occupational and medical history.
- Assure employees of confidentiality.
- Require workers to report any suspected exposures, regardless of degree.
- Require workers to bring any unusual conditions to the physician's attention. Employee training should emphasize that vague disturbances or apparently minor complaints (such as skin irritation or headaches) may be important.

Except for the pre-employment examination, which helps to screen out those individuals who may be at greater risk of injury or illness, medical surveillance does not reduce the risk of initial illness or injury. Rather it helps detect signs and symptoms of disease so that the appropriate treatment or action can be taken without delay. However, signs or symptoms of chemical exposure may be subtle and therefore difficult to detect or treat. Thus, at hazardous waste sites it is particularly important to remember the critical role of prevention—through the diligent application of a comprehensive health and safety program—in maintaining employee health.

Table 3. Some Recommendations for a Site Medical Program

COMPONENT	RECOMMENDATIONS
PRE-EMPLOYMENT SCREENING	• Medical history. • Occupational history. • Physical examination. • Determination of ability to work while wearing protective equipment. • Baseline monitoring for specific exposures.[a]
PERIODIC MEDICAL EXAMINATIONS	• At least yearly medical and occupational history and physical examination; testing based on (1) examination results and (2) exposures. • More frequent testing based on exposure to specific hazards.[a]
EMERGENCY TREATMENT	• Provide emergency first aid and decontamination on site. • Develop liaison with local hospital and medical specialists. • Arrange for transport of victims. • Arrange for transfer of medical records; give details of incident and medical history to next care provider.
NON-EMERGENCY TREATMENT	• Develop mechanism for evaluation of possible site-related illness and non-emergency health care.
TERMINATION EXAMINATION	• An interval medical history of the period since the last full examination. • A full examination if the worker has experienced any exposures or symptoms since the last full examination, or if the last full examination was given more than 6 months prior to termination.
RECORDKEEPING AND REVIEW	• Maintain and provide access to medical records in accordance with OSHA regulations. • Report and record occupational injuries and illnesses. • Review Site Safety Plan regularly to determine if additional testing is needed. • Review program periodically. Focus on current site hazards, exposures, and industrial hygiene standards.

[a]Some standard occupational medical tests may not be totally appropriate for hazardous waste sites. Most testing recommendations have not been critically evaluated for efficacy.

6. Site Characterization

Site characterization is the process of data gathering and assessment. It provides the information needed to identify site hazards and select worker protection methods. Accurate, detailed, and comprehensive information concerning site conditions enables the Site Safety Officer to tailor protective measures to the site's actual hazards. The person with primary responsibility for site characterization and assessment is the Project Team Leader. In addition, outside experts, such as chemists, health physicists, industrial hygienists and toxicologists, may be needed to accurately and fully interpret all the available information on site conditions. Site characterization generally proceeds in three phases (Figure 2). The information obtained at each phase is used to assess hazards and to develop or modify a Site Safety Plan for the next phase of characterization.

As part of site characterization, workers suited in Level A protective ensembles (see Table 4) work in pairs when investigating confined spaces.

Sample jars are labelled prior to sampling as part of site documentation procedures.

OFFSITE CHARACTERIZATION

Before initial site entry, information from offsite interviews, records research, visual observation, monitoring, and sampling at the perimeter should be obtained. This information is then used to evaluate the potential hazards, particularly inhalation hazards that may be immediately dangerous to life or health (IDLH) and other dangerous conditions, and to develop a Site Safety Plan for initial entry which specifies protective equipment and other safety controls.

ONSITE SURVEY

The purpose of this next phase of characterization is to verify and supplement information from the offsite characterization. After carefully evaluating probable conditions based on offsite data, priorities should be established for hazard assessment during the onsite survey. The composition of the entry team depends on the site characteristics, but should always consist of at least four people: two workers who will enter the site and two outside support people. Upon entering the site, workers should first monitor for ionizing radiation, and IDLH and other dangerous conditions (see Table 1). If these hazards do not exist, air monitoring and visual inspection of the site (including the condition of waste containers, the physical condition of materials, the potential pathways of dispersion, physical hazards, etc.) may proceed. Information from the onsite survey is used to assess the safety of the site for cleanup activities and to modify the Site Safety Plan for the next phase of

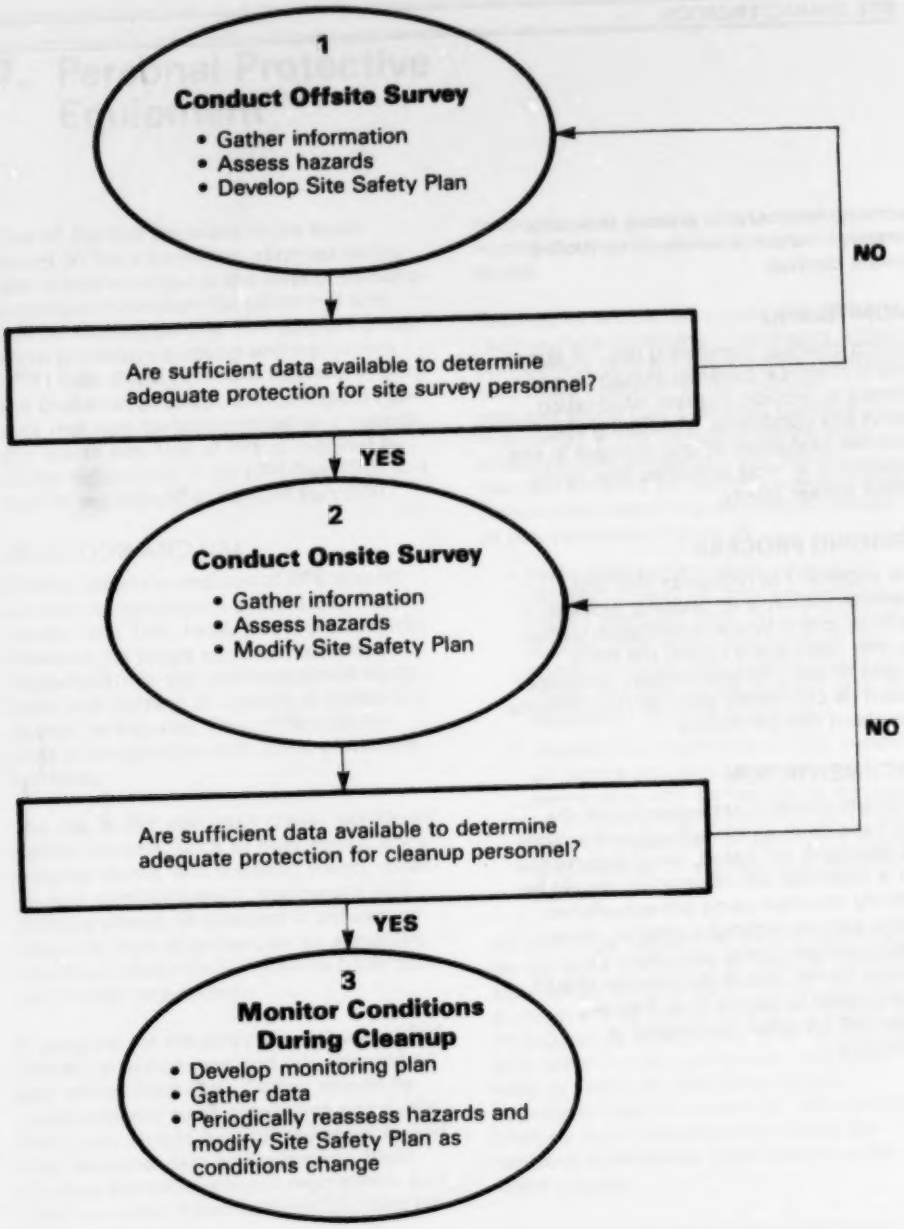


Figure 2. Major Phases of Site Characterization.

activity. Any hazards present should be removed, where possible, or controlled before cleanup.

MONITORING

During cleanup, monitoring (e.g., of atmospheric chemical hazards) should be performed to provide ongoing information about site conditions. Monitoring also includes evaluation of any changes in site conditions or work activities that could affect worker safety.

ONGOING PROCESS

It is important to recognize that site characterization is an ongoing process. In addition to the formal information gathering that takes place during the three phases of site characterization, personnel should be constantly alert for new information about site conditions.

DOCUMENTATION

Since site characterization provides the data base upon which subsequent actions and decisions are based, good documentation is essential. All information should be carefully recorded using pre-established means such as logbooks, graphs, photographs, sample labels, and chain-of-custody forms; and all documents should be controlled to ensure that they are accounted for when the project is completed.

7. Personal Protective Equipment

One of the first decisions to be made based on the information obtained during site characterization is the level of personal protection necessary for personnel who will be working on site. The purpose of personal protective clothing and equipment (PPE) is to shield or isolate individuals from the chemical, physical, and biological hazards that may be encountered at a hazardous waste site. Use of PPE is required by OSHA regulations in 29 CFR Part 1910 and by EPA regulations in 40 CFR Part 300.

SELECTION AND USE

Careful selection and use of PPE should protect the respiratory system, skin, eyes, hands, face, feet, head, body, and hearing. However, no single piece of protective equipment, nor any combination of equipment and clothing is capable of protecting against all hazards. Thus, PPE must be used in conjunction with other protective methods.

The use of PPE can itself create significant worker hazards, such as heat stress, physiological stress, and impaired vision, mobility, and communication. Equipment and clothing should be selected to provide an adequate level of protection for a specific situation; overprotection can be hazardous and should be avoided.

A program for the selection and use of PPE should be established and documented as part of the Work Plan. Copies should be made available to all employees and a reference copy should be available at each work site. Technical data on equipment, maintenance manuals, relevant regulations, and other essential information should also be made available.

RESPIRATORY EQUIPMENT

Respiratory protection is extremely important since inhalation of toxic substances is a major route of exposure. Respiratory protective devices consist of a facepiece connected to an air source or an air-purifying device.

Respirators with an air source are called "atmosphere-supplying" respirators. When atmosphere-supplying respirators are used, only those operated in the positive-pressure mode (i.e., a positive pressure is maintained in the facepiece during both inhalation and exhalation) are recommended for work on hazardous waste sites. Atmosphere-supplying respirators consist of two types (see Figure 3):

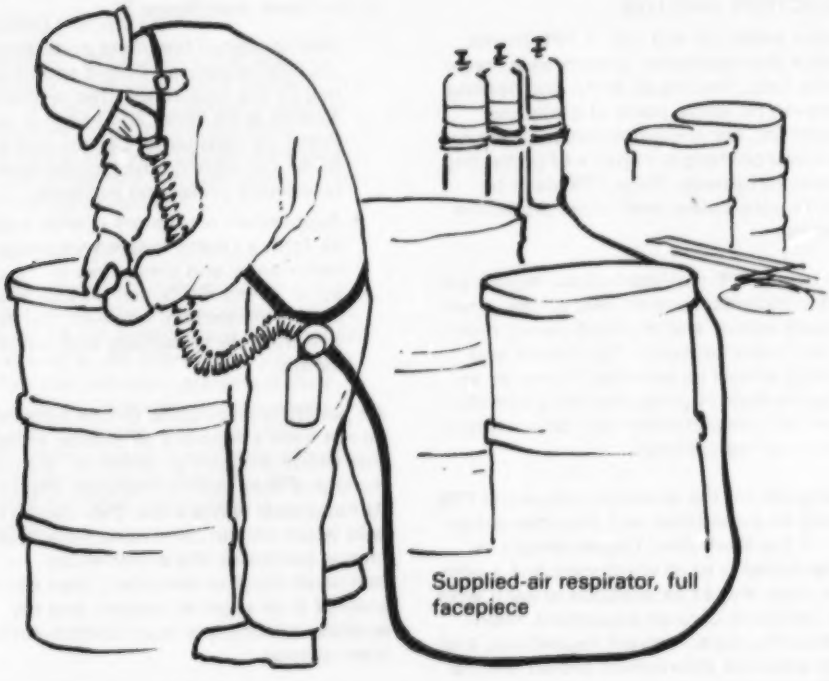
- *Self-contained breathing apparatus (SCBAs)* supply air from a source carried by the user. They offer protection against most types and levels of airborne contaminants. Certain types of SCBA can provide the highest level of respiratory protection available.
- *Supplied-air respirators (SARs)* supply air from a source located some distance away and connected to the user by an airline. SARs can provide a high level of protection, however, the airline is vulnerable to damage and contamination.

Air-purifying respirators, on the other hand, do not have a separate air source. Instead, they utilize ambient air which is "purified" through a filter before inhalation (Figure 4). At hazardous waste sites, they can be used only when certain conditions have been met; in particular, the airborne contaminants must be identified; their concentrations in air must be known; and the ambient atmosphere must contain sufficient oxygen.

All types of respirators have advantages and disadvantages. The decision about which respirator type offers adequate protection depends on site-specific conditions and must be made with the advice of qualified personnel.

Emergency escape SCBA, hood type

Self-contained breathing apparatus (SCBA), full facepiece



Supplied-air respirator, full facepiece

Figure 3. Types of Atmosphere-Supplying Respirators.

Figure 4. Types of Air-Purifying Respirators.

PROTECTIVE CLOTHING

Protective clothing provides varying degrees of partial and/or total body protection from chemical exposure, fire, minor blasts or explosions. Such clothing ranges from gloves, aprons, leggings, and sleeve protectors to fully-encapsulating suits (Figure 5). In addition, various accessories may be used with a PPE ensemble. These include flashlights, two-way radios, and safety belts.

Each type of protective clothing has a specific purpose, as well as limitations. For example, some chemical-protective clothing may protect against some chemicals but not others. Likewise, clothing that protects against fire or heat generally does not protect against chemical exposure.

Selection of protective clothing is a complex task and should be performed by personnel with training and experience. Clothing is selected by comparing its performance characteristics to the requirements and limitations of the site and of the task, and involves considerations such as:

- The resistance of clothing material to permeation and degradation by chemicals known or suspected to be on site.
- The resistance of clothing to penetration by chemicals through such channels as design or construction imperfections, porous zippers, stitched seams, button holes, and pinholes.
- The ability of the clothing material to withstand physical stress and extremes of heat and cold.
- Whether the clothing is flexible enough to allow workers to carry out tasks.
- The ease of decontaminating the clothing; the compatibility of the clothing with decontamination solutions and other equipment.

ENSEMBLES

Individual components of clothing and respiratory equipment must be assembled into an ensemble to provide the appropriate level of protection. EPA typically uses four ensembles that provide different levels of protection: A, B, C, and D (Table 4). The EPA ensembles can be used as general guidelines for ensemble creation; however, at each site, ensembles must be tailored to meet site- and task-specific conditions.

TRAINING

Personal protective equipment is only effective when used properly. All workers at a hazardous waste site must be trained at least annually in PPE operation and use, including OSHA requirements, inspection, donning, checking, fitting, doffing, and maintenance; and emergency procedures and self-rescue in the event of equipment failure. Since the discomfort and inconvenience of PPE may create worker resistance towards its conscientious use, training should emphasize the need for PPE and motivate workers to wear and use it properly.

HEAT STRESS

Wearing impermeable or semipermeable protective clothing and equipment adds weight and bulk, severely reduces the body's access to normal heat exchange mechanisms (evaporation, convection, and radiation), and increases energy expenditure. This puts a worker at considerable risk of developing heat stress—a condition that results when the body is unable to release excess heat. Symptoms range from transient heat fatigue and lowered work tolerance to illness and death (Table 5).

Individuals vary in their susceptibility to heat stress. Factors that may predispose someone to heat stress include poor physical fitness, lack of acclimatization, age,

Apron, gloves, hardhat, faceshield, boot covers

Fully-encapsulating suit

Figure 5. Examples of Protective Clothing.

Table 4. Sample Protective Ensembles[a]

LEVEL OF PROTECTION	EQUIPMENT	PROTECTION PROVIDED	SHOULD BE USED WHEN:	LIMITING CRITERIA
A	RECOMMENDED: • Pressure-demand, full-facepiece SCBA or pressure-demand supplied-air respirator with escape SCBA. • Fully-encapsulating, chemical-resistant suit. • Inner chemical-resistant gloves. • Chemical-resistant safety boots/shoes. • Two-way radio communications. OPTIONAL: • Cooling unit. • Coveralls. • Long cotton underwear. • Hard hat. • Disposable gloves and boot covers.	The highest available level of respiratory, skin, and eye protection.	• The chemical substance has been identified and requires the highest level of protection for skin, eyes, and the respiratory system based on either: — measured (or potential for) high concentration of atmospheric vapors, gases, or particulates or — site operations and work functions involving a high potential for splash, immersion, or exposure to unexpected vapors, gases, or particulates harmful to skin or capable of being absorbed through the intact skin. • Substances with a high degree of hazard to the skin are known or suspected to be present, and skin contact is possible. • Operations must be conducted in confined, poorly ventilated areas until the absence of conditions requiring Level A protection is determined.	• Fully-encapsulating suit material must be compatible with the substances involved.

Table 4 (Cont.)

LEVEL OF PROTECTION	EQUIPMENT	PROTECTION PROVIDED	SHOULD BE USED WHEN:	LIMITING CRITERIA
B	RECOMMENDED: • Pressure-demand, full-facepiece SCBA or pressure-demand supplied-air respirator with escape SCBA. • Chemical-resistant clothing (overalls and long-sleeved jacket; hooded, one- or two-piece chemical splash suit; disposable chemical-resistant one-piece suit). • Inner and outer chemical-resistant gloves. • Chemical-resistant safety boots/shoes. • Hard hat. • Two-way radio communications. OPTIONAL: • Coveralls. • Disposable boot covers. • Face shield. • Long cotton underwear.	The same level of respiratory protection but less skin protection than Level A. It is the minimum level recommended for initial site entries until the hazards have been further identified.	• The type and atmospheric concentration of substances have been identified and require a high level of respiratory protection, but less skin protection. This involves atmospheres: — with IDLH concentrations of specific substances that do not represent a severe skin hazard; or — that do not meet the criteria for use of air-purifying respirators. • Atmosphere contains less than 19.5 percent oxygen. • Presence of incompletely identified vapors or gases is indicated by direct-reading organic vapor detection instrument, but vapors and gases are not suspected of containing high levels of chemicals harmful to skin or capable of being absorbed through the intact skin.	• Use only when the vapor or gases present are not suspected of containing high concentrations of chemicals that are harmful to skin or capable of being absorbed through the intact skin. • Use only when it is highly unlikely that the work being done will generate high concentrations of vapors, gases, or particulate or splashes of material that will affect exposed skin.

[a]Based on EPA protective ensembles.

Table 4 (Cont.)

LEVEL OF PROTECTION	EQUIPMENT	PROTECTION PROVIDED	SHOULD BE USED WHEN:	LIMITING CRITERIA
C	RECOMMENDED: • Full-facepiece, air-purifying, canister-equipped respirator. • Chemical-resistant clothing (overalls and long-sleeved jacket; hooded, one- or two-piece chemical splash suit; disposable chemical-resistant one-piece suit). • Inner and outer chemical-resistant gloves. • Chemical-resistant safety boots/shoes. • Hard hat. • Two-way radio communications. OPTIONAL: • Coveralls. • Disposable boot covers. • Face shield. • Escape mask. • Long cotton underwear.	The same level of skin protection as Level B, but a lower level of respiratory protection.	• The atmospheric contaminants, liquid splashes, or other direct contact will not adversely affect any exposed skin. • The types of air contaminants have been identified, concentrations measured, and a canister is available that can remove the contaminant. • All criteria for the use of air-purifying respirators are met.	• Atmospheric concentration of chemicals must not exceed IDLH levels. • The atmosphere must contain at least 19.5 percent oxygen.
D	RECOMMENDED: • Coveralls. • Safety boots/shoes. • Safety glasses or chemical splash goggles. • Hard hat. OPTIONAL: • Gloves. • Escape mask. • Face shield.	No respiratory protection. Minimal skin protection.	• The atmosphere contains no known hazard. • Work functions preclude splashes, immersion, or the potential for unexpected inhalation of or contact with hazardous levels of any chemicals.	• This level should not be worn in the Exclusion Zone. • The atmosphere must contain at least 19.5 percent oxygen.

Table 5. Signs and Symptoms of Heat Stress

- *Heat rash* may result from continuous exposure to heat or humid air.
- *Heat cramps* are caused by heavy sweating with inadequate electrolyte replacement. Signs and symptoms include:
  - muscle spasms
  - pain in the hands, feet, and abdomen
- *Heat exhaustion* occurs from increased stress on various body organs including inadequate blood circulation due to cardiovascular insufficiency or dehydration. Signs and symptoms include:
  - pale, cool, moist skin
  - heavy sweating
  - dizziness
  - nausea
  - fainting
- *Heat stroke* is the most serious form of heat stress. Temperature regulation fails and the body temperature rises to critical levels. Immediate action must be taken to cool the body before serious injury and death occur. Competent medical help must be obtained. Signs and symptoms are:
  - red, hot, usually dry skin
  - lack of or reduced perspiration
  - nausea
  - dizziness and confusion
  - strong, rapid pulse
  - coma

dehydration, obesity, alcohol and drug use, infection, sunburn, chronic disease, and diarrhea. Because heat stress is one of the most common, and potentially serious, illnesses at hazardous waste sites, regular monitoring and preventive precautions are vital. Some of these precautions include adjusting work schedules, providing shelter or shaded areas, and maintaining workers' body fluids by urging them to drink liquids.

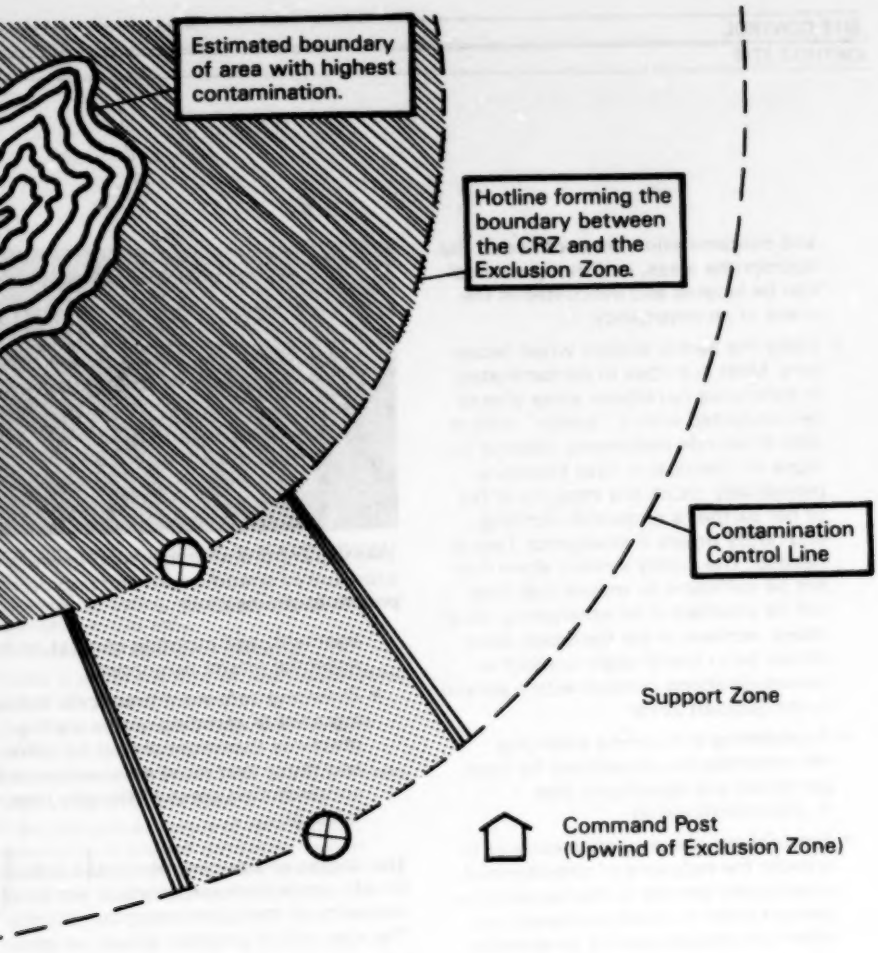
8. Site Control

To create and maintain a safe working environment, activities at a hazardous waste site must be controlled. A site control program should be instituted prior to site characterization and continue throughout site activities. Site control serves several purposes: it minimizes the potential for worker contamination or injury, protects the public from the site's hazards, facilitates work activities, and prevents vandalism. Site control is especially important in emergency situations. Site control procedures may include:

- *Compiling a site map* showing topographic features, prevailing wind direction, drainage, and the locations of buildings, containers, impoundments, pits, ponds, and tanks. The map should be updated throughout the course of site operations to reflect changes in site conditions and activities. The map may be used to plan site activities; assign personnel; identify access routes, evacuation routes, and problem areas; and identify areas of the site that require use of personal protective equipment.
- *Preparing the site* for cleanup activities. Preparation can be as hazardous as cleanup. For this reason, extreme care for worker safety must be taken. Table 6 summarizes the steps that may be taken to prepare a site.
- *Establishing work zones.* To reduce the accidental spread of hazardous substances by workers from the contaminated area of the site to the clean area, hazardous waste sites should be divided into as many different zones as necessary to meet operational and safety objectives. Three frequently used zones are (see Figure 6):
  - The Exclusion Zone, i.e., the contaminated area of a site.
  - The Contamination Reduction Zone (CRZ) where decontamination takes place.
  - The Support Zone, i.e., the uncontaminated area within which hazardous conditions should not exist.
- Defining separate zones and tracking entry and exit from these zones helps ensure that personnel are protected against hazards, that work activities

Table 6. Site Preparation

- Construct roadways to provide ease of access and a sound roadbed for heavy equipment and vehicles.
- Arrange traffic flow patterns to ensure safe and efficient operations.
- Eliminate physical hazards from the work area as much as possible, including:
  - ignition sources in flammable hazard areas.
  - exposed or ungrounded electrical wiring, and low overhead wiring that may entangle equipment.
  - sharp or protruding edges, such as glass, nails, and torn metal, which can puncture protective clothing and equipment and inflict puncture wounds.
  - debris, holes, loose steps or flooring, protruding objects, slippery surfaces, or unsecured railings, which can cause falls, slips, and trips.
  - unsecured objects, such as bricks and gas cylinders, near the edges of elevated surfaces, such as catwalks, roof tops, and scaffolding, which may dislodge and fall on workers.
  - debris and weeds that obstruct visibility.
- Install skid-resistant strips and other anti-skid devices on slippery surfaces.
- Construct operation pads for mobile facilities and temporary structures.
- Construct loading docks, processing and staging areas, and decontamination pads.
- Provide adequate illumination for work activities. Equip temporary lights with guards to prevent accidental contact.
- Install all wiring and electrical equipment in accordance with the National Electric Code.


Estimated boundary of area with highest contamination.
Hotline forming the boundary between the CRZ and the Exclusion Zone.
Contamination Control Line
Support Zone
Command Post (Upwind of Exclusion Zone)

Access Control Points which control the flow of personnel and equipment into and out of the Exclusion Zone.

Decontamination Reduction Corridor where decontamination takes place.

Contamination Reduction Zone (CRZ).

Exclusion Zone. Buffer zone between CRZ and area of highest contamination.

gure 6. Site Work Zones.

and contamination are confined to the appropriate areas, and that personnel can be located and evacuated in the event of an emergency.

- *Using the buddy system* when necessary. Most activities in contaminated or otherwise hazardous areas should be conducted with a "buddy" who is able to provide assistance, observe for signs of chemical or heat exposure, periodically check the integrity of his or her partner's protective clothing, and notify others if emergency help is needed. The buddy system alone may not be sufficient to ensure that help will be provided in an emergency. At all times, workers in the Exclusion Zone should be in line-of-sight contact or communications contact with a person in the Support Zone.
- *Establishing and strictly enforcing decontamination procedures* for both personnel and equipment (see *9. Decontamination*).
- *Establishing site security measures* to prevent the exposure of unauthorized, unprotected people to site hazards; to prevent theft; to avoid increased hazards from people seeking to abandon other wastes on the site; and to minimize interference with safe working procedures. Security measures may include establishing an ID system, erecting a fence, posting signs, hiring security guards, and enlisting public law enforcement agencies.
- *Setting up communication networks.* An internal communications network is required to alert workers to emergencies, pass along safety information, communicate changes in the work to be accomplished, and maintain site control. An external communication system between onsite and offsite personnel is necessary to coordinate emergency response, report to management, and maintain contact with essential offsite personnel.
- *Enforcing safe work practices,* including a list of standing orders stating practices that must always be followed and those that must never occur in the contaminated areas of the site (see Table 7).

Warning signs and fences help to prevent exposure of unauthorized and unprotected people to site hazards.

The degree of site control needed depends on site size and characteristics, and on the proximity of the surrounding community. The site control program should be established in the planning stages of a project and should be modified as necessary based on new information and site assessments.

Table 7. Sample Standing Orders

FOR PERSONNEL ENTERING THE CONTAMINATION REDUCTION ZONE:
No smoking, eating, drinking, or application or cosmetics in this zone.
No matches or lighters in this zone.
Check in at the entrance Access Control Point before you enter this zone.
Check out at the exit Access Control Point before you leave this zone.
FOR PERSONNEL ENTERING THE EXCLUSION ZONE:
No smoking, eating, drinking, or application of cosmetics in this zone.
No matches or lighters in this zone.
Check in at the entrance Access Control Point before you enter this zone.
Check out at the exit Access Control Point before you leave this zone.
Always have your buddy with you in this zone.
Wear an SCBA in this zone.
If you discover any signs of radioactivity, explosivity, or unusual conditions such as dead animals at the site, exit immediately and report this finding to your supervisor.

9. Decontamination

Decontamination—the process of removing or neutralizing contaminants on personnel and equipment—is an essential site control measure at any site containing chemical or pathogenic hazards. Decontamination is critical to health and safety: it protects workers from hazardous substances that may contaminate and eventually permeate protective clothing, respiratory equipment, tools, vehicles, and other equipment; it minimizes the transfer of harmful materials into clean areas; it prevents the mixing of incompatible chemicals; and it protects the community by preventing the uncontrolled transport of contaminants from the site.

PLANNING

The Site Safety Plan must include a decontamination program, which must be established before any personnel or equipment enter areas where the potential for exposure to hazardous substances exists. The plan must be revised whenever the type of PPE used on site changes, the site conditions change, or the site hazards are reassessed based on new information.

PREVENTION

The first step in decontamination is prevention, by establishing standard operating procedures that minimize contact with waste. Such procedures include:

- Using remote sampling, handling, and container-opening techniques.
- Protecting monitoring and sampling equipment by placing it in bags.
- Stressing work habits that minimize contact with hazardous substances.
- Wearing disposable outer garments.
- Using disposable equipment where appropriate.
- Enclosing the source of contamination.

SCOPE

All personnel, clothing, equipment, and samples leaving the contaminated area of a site must be decontaminated. Decontamination methods either physically remove contaminants, inactivate contaminants by chemical detoxification or disinfection/sterilization, or remove contaminants by a combination of both physical and chemical means. The level and type of decontamination required depends on site-specific factors such as the type of wastes present and the potential for contamination.

TESTING FOR EFFECTIVENESS

The effectiveness of decontamination methods varies depending on the properties of the contaminants and the nature of the contamination. For example, surface contaminants in PPE may be easy to remove, whereas substances that have permeated into the material may be difficult or impossible to remove. There is no reliable test to immediately determine how effective decontamination is. In some cases, effectiveness can be estimated by visual observation using natural or ultraviolet light. Other methods that may be useful in assessing the effectiveness of decontamination are wipe sampling using a dry or wet cloth, glass fiber filter paper, or swab; cleaning solution analysis, in which the level of contaminants left in the cleaning solutions is analyzed to determine whether additional rinsing is needed; and testing, through laboratory analysis, of protective garments for permeated chemicals.

LAYOUT AND PROCEDURES

At a hazardous waste site, decontamination facilities should be located in the Contamination Reduction Zone (CRZ), between the contaminated zone (often called the Exclusion Zone) and the clean zone (often called the Support Zone). Decontamination

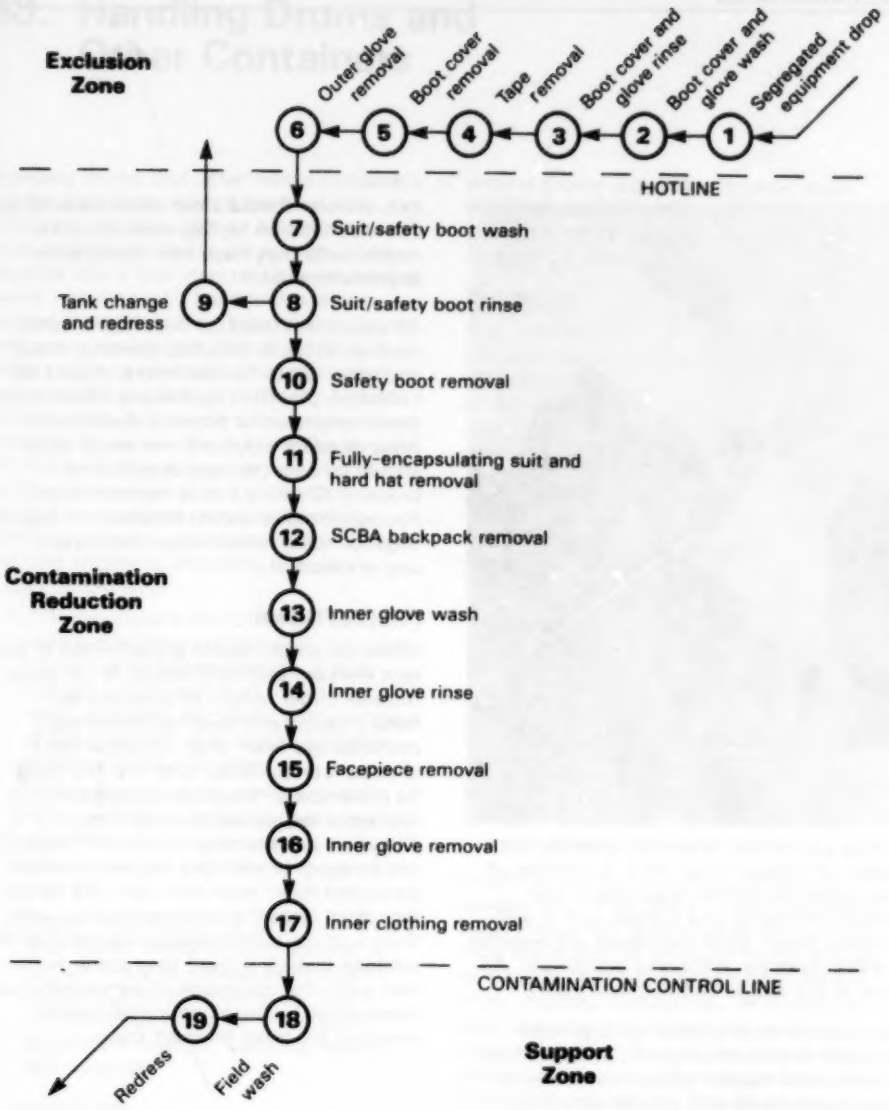


Figure 7. Sample Decontamination Stations (1-19) and Layout for Workers Wearing Level A Protection (maximum protection, see Table 4).

Gross contaminants can be removed with water or a liquid rinse. Here, a member of the decontamination team rinses and scrubs the boots of a worker with a soft-bristled brush. Both individuals are wearing Level C personal protective equipment. A tarp in the foreground catches runoff.

procedures must provide an organized process to reduce levels of contamination. Outer, more heavily contaminated items (e.g., outer boots and gloves) should be decontaminated and removed first, followed by inner, less contaminated items. Each procedure should be performed at a separate station to prevent cross contamination. Stations should be arranged in order of decreasing contamination, preferably in a straight line (see Figure 7). Entry and exit points should be conspicuously marked; dressing stations for entry should be separate from redressing stations for exit. No one should enter clean areas of the decontamination facility, such as locker rooms, until they have been completely decontaminated.

All equipment used for decontamination, such as buckets, brushes, clothing, tools, and other contaminated items, should be collected, placed in containers, labeled, and decontaminated or properly disposed of. Also, all spent solutions and wash water should be collected and disposed of properly. Clothing that is not completely decontaminated should be placed in plastic bags, pending further decontamination and/or disposal.

PRECAUTIONS

While decontamination is performed to protect worker health and safety, it can pose hazards under certain circumstances. Before decontamination solutions and materials are used, their chemical and physical compatibility with the PPE must be determined. Any decontamination method that permeates, degrades, damages, or otherwise impairs PPE should not be used. In addition, decontamination personnel must wear adequate PPE to protect them from the decontamination solutions and any contaminants adhering to the clothing and equipment they come in contact with. Decontamination personnel must themselves be decontaminated before entering the clean Support Zone.

10. Handling Drums and Other Containers

Handling drums and other waste containers can be one of the most hazardous site activities. Hazards include detonations, fires, explosions, vapor generation, and physical injury that may result from moving heavy containers by hand and working around stacked drums, deteriorated drums, and heavy equipment. Proper work practices—such as minimizing handling, and using equipment and procedures to isolate workers from hazardous substances—are essential to reduce the risks to site personnel. Figure 8 illustrates one way of organizing the basic steps of drum handling: inspection, planning, staging, handling, opening, sampling, characterization, bulking, and shipment. Handling operations must comply with:

- EPA regulations (40 CFR Part 265), which stipulate requirements for types of containers; maintenance of containers; maintenance of structures, such as berms and dikes, that contain leaking wastes; and design and maintenance of storage areas.
- DOT regulations (49 CFR Parts 171 through 178), which stipulate requirements for shipping containers and procedures for shipment of hazardous wastes.
- OSHA regulations (29 CFR Parts 1910 and 1926), which include general requirements and standards for storing, containing, and handling chemicals and containers, and for maintaining equipment used for handling hazardous materials.

INSPECTION

Prior to handling, drums must be visually inspected to gain as much information as possible about their contents. Visual inspection may reveal signs of the drum's contents (e.g., symbols, words, or other marks), or signs that a drum is deteriorated (e.g., corrosion, rust, leaks) or under pressure (e.g., swelling, bulging). Monitoring around drums (e.g., using organic vapor monitors, radiation survey instruments, etc.) may reveal additional information about their contents.

PLANNING

The results of the preliminary inspection can be used to develop a plan (part of the Work Plan) that specifies the extent of container handling necessary, the personnel assigned to the job, and the most appropriate procedures based on the hazards associated with the probable drum contents.

HANDLING, OPENING, AND SAMPLING

The primary purposes of handling are:

- To respond to obvious problems that might impair worker safety, such as the presence of explosive or radioactive substances.
- To unstack and reorient drums for sampling.
- To organize drums into different areas on site to facilitate characterization and cleanup activities.

Drums and other containers should be handled only if necessary, since accidents occur frequently during handling. To minimize the likelihood of injury, drums should be handled, opened and sampled using a drum grappler, hydraulically or pneumatically operated impact wrench or drum piercer, or other piece of equipment that physically separates the worker from the drum. Bulging, leaking, buried, open, and deteriorated drums, or drums containing radioactive waste, explosive or shock-sensitive waste, or packaged wastes (lab packs), may be particularly hazardous and must be handled with extreme caution, using additional safety precautions. If at all possible, drums should be opened and sampled in place to minimize the potential for accidents.

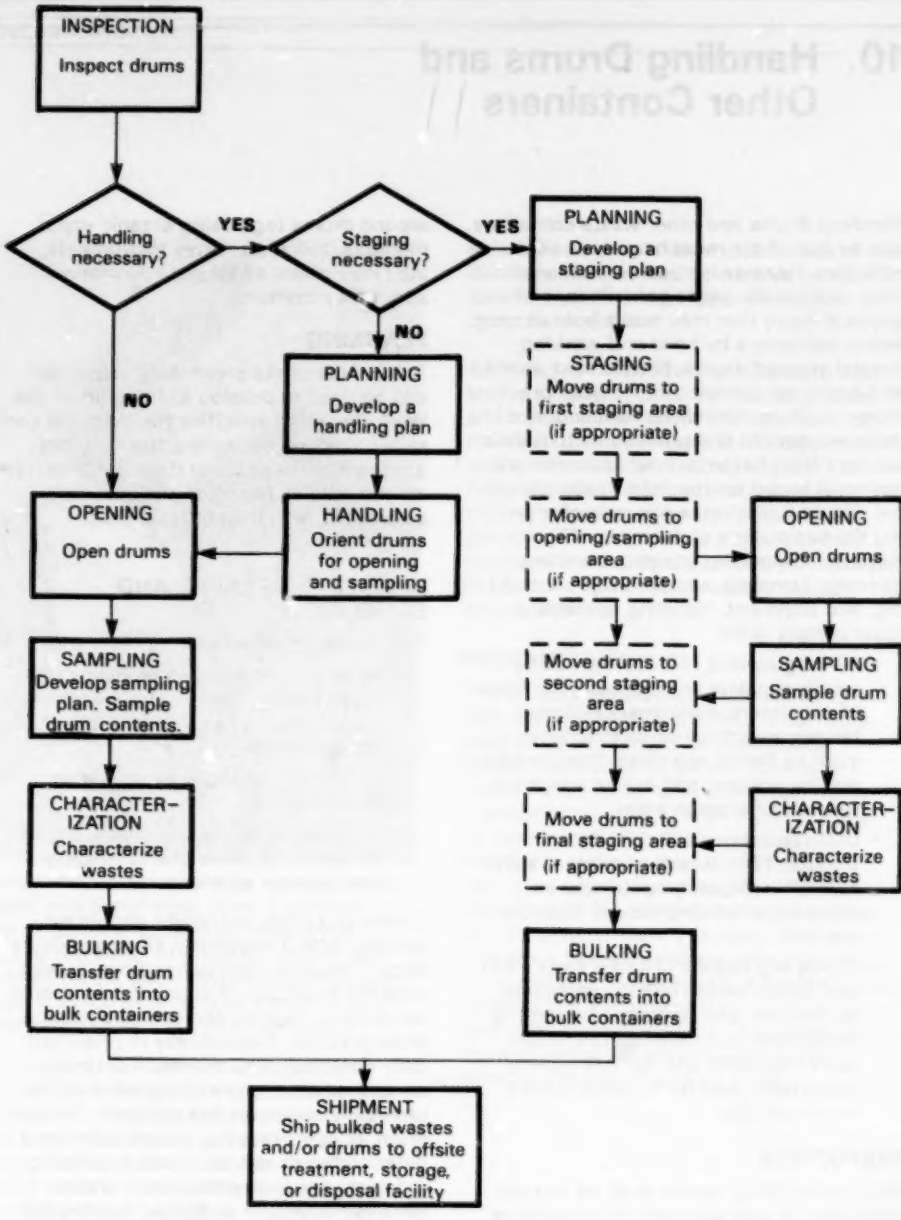


Figure 8. Flow Chart for Drum Handling. (Dashed boxes indicate optional steps. Number of staging areas necessary is site specific.)

CHARACTERIZATION

After drums have been sampled, their contents should be characterized and classified into general categories such as inorganic acids, heavy metals, pesticides, etc. Following characterization, compatible drum contents may be mixed together and placed in bulk containers such as tanks or vacuum trucks for transport to treatment, storage or disposal facilities, or the drums may be "staged" or organized to facilitate further characterization and site cleanup.

STAGING

Although every attempt should be made to minimize drum handling, drums must sometimes be staged (i.e., moved in an organized manner to predesignated areas) to facilitate waste characterization and cleanup and to protect drums from potentially hazardous site conditions that could result in explosions or ignition. Staging involves a tradeoff between the increased hazards associated with drum movement and the decreased hazards associated with the enhanced organization and accessibility of materials. Figure 9 shows possible staging areas at a hazardous waste site.

BULKING AND SHIPMENT

The final container staging (bulking) area should be located as close as possible to the site exit to facilitate offsite shipment of wastes and to enhance the safety of these operations. A traffic circulation plan that minimizes conflict between cleanup teams and waste haulers should be devised. Adequate space for vehicles to turn around should be provided, and vehicle drivers should be outfitted with appropriate protective equipment. All drums should be tightly sealed before loading, and leaking or deteriorated drums should be placed in an overpack drum prior to shipment. Drums should not be double stacked for shipment. All drums must be secured to prevent shifting during transport. Vehicles should be decontaminated prior to leaving the site to ensure that contaminants are not carried onto public roads. Lastly, procedures for responding quickly to offsite vehicle breakdowns/accidents should be developed to ensure minimal public impact.

Single-stacked overpack drums awaiting transport offsite. Worker suited in Level C personal protective equipment will spread a tarp over the drums to protect them during transport.

OTHER CONTAINERS

Other waste containers that may be present at a site include tanks, vaults, vacuum trucks, compressed gas cylinders, ponds, and lagoons. Each requires special handling procedures. For example, with elevated tanks, safety lines and harnesses may be necessary to prevent workers from falling. Ponds and lagoons present a danger of workers drowning—particularly personnel suited in protective equipment—and may require special safety gear. However, there are several basic safe handling principles that apply to all containers, regardless of their position, shape or size: advance planning, minimizing contact with the container and the waste, carefully inspecting the container prior to opening, and characterizing the waste prior to bulking or shipment.

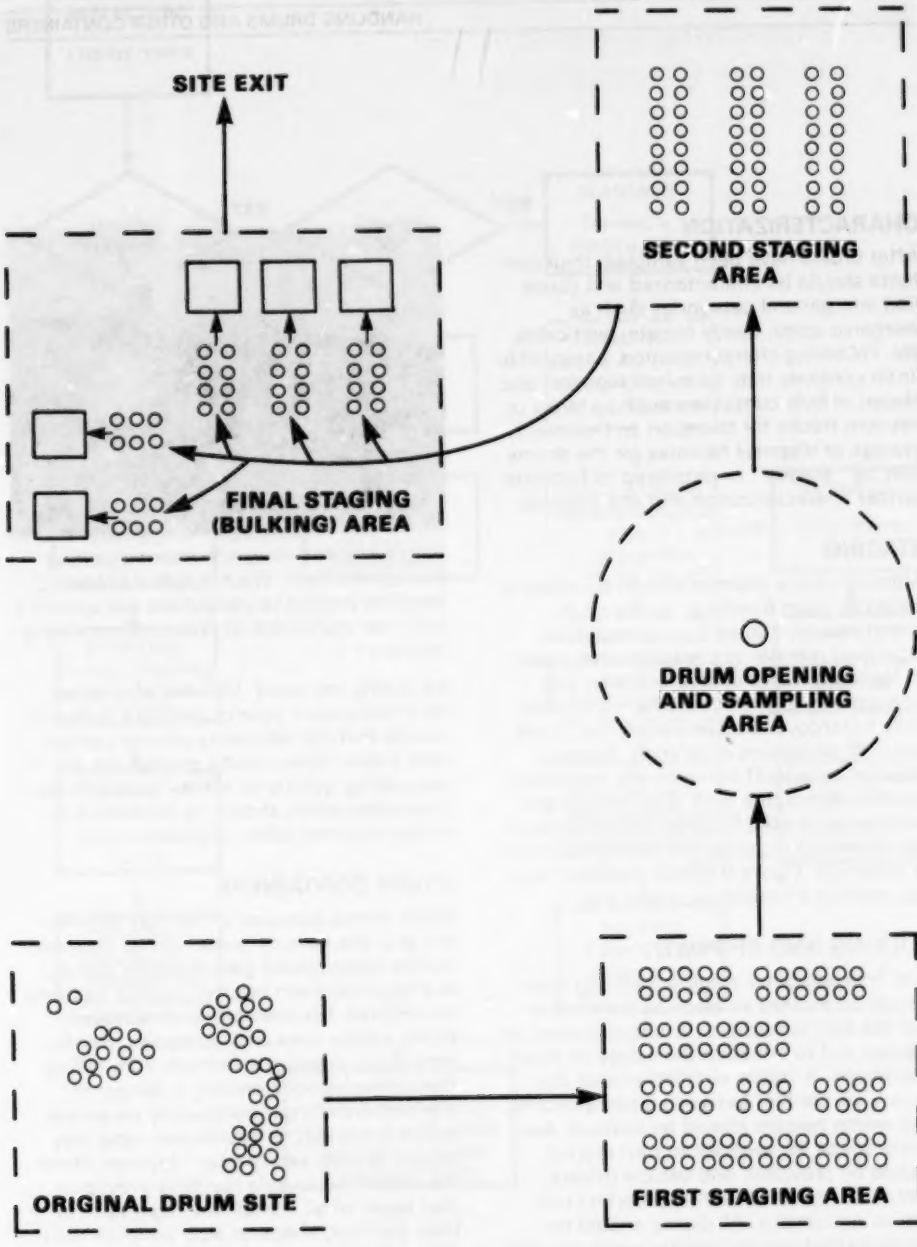


Figure 9. Possible Staging Areas at a Hazardous Waste Site.

11. Site Emergencies

Unforeseen circumstances may suddenly create unexpected emergencies at hazardous waste sites. An emergency may be as limited as a worker experiencing heat stress, or as vast as an explosion that spreads toxic fumes throughout a community. Some common causes of emergencies include fire or explosion, chemical leaks, chemical reactions, container collapse, release of toxic vapors, heat stress, PPE failure, and physical injury.

Site emergencies are potentially complex because uncontrolled toxic chemicals may be numerous and unidentified, and their effects may be synergistic. Advance planning, including anticipation of emergency scenarios and thorough preparation for contingencies, is therefore essential to protect worker and community health and safety. Emergency response delays of minutes can create life-threatening situations; the rapidity of response can mean the difference between life and death. Therefore, it is essential that personnel be able to immediately respond or rescue, and that equipment be on hand and in good working order.

PLANNING

A Contingency Plan that sets forth policies and procedures for responding to emergencies should be developed for each site. A Contingency Plan is a written document (generally a separate section within the Site Safety Plan) that incorporates the following:

- All individuals and teams who will participate in emergency response, and their roles, responsibilities, and lines of authority.
- A detailed site map showing the locations and types of hazards, site terrain, evacuation routes, refuges, decontamination stations, and offsite populations at risk.
- Procedures for communicating on site (e.g., bullhorns, sirens, hand signals) and offsite (e.g., key phone numbers, contact names, two-way radio).
- Equipment necessary to rescue and treat victims, to protect response personnel, and to mitigate hazardous conditions on the site.
- Medical treatment/first aid techniques, including CPR.
- Emergency response procedures that encompass all phases of response operations, from initial notification through preparation of equipment and personnel for the next emergency.
- Procedures for emergency decontamination, including decontaminating the victim(s), protecting medical personnel, and disposing of contaminated PPE and decontamination solutions.
- Site security and control measures to ensure that only authorized personnel enter hazardous areas during emergency situations.
- Procedures for documenting and reporting the incident.

The Contingency Plan should be rehearsed regularly using drills and mock situations, and reviewed periodically in response to new or changing site conditions or information.

EMERGENCY RESPONSE PROCEDURES

Figure 10 outlines a possible flow of operations during an actual emergency. Operations can be divided into three categories:

- *Preparation*, which involves assessing the situation, allocating personnel and equipment for response, and requesting aid from outside sources.

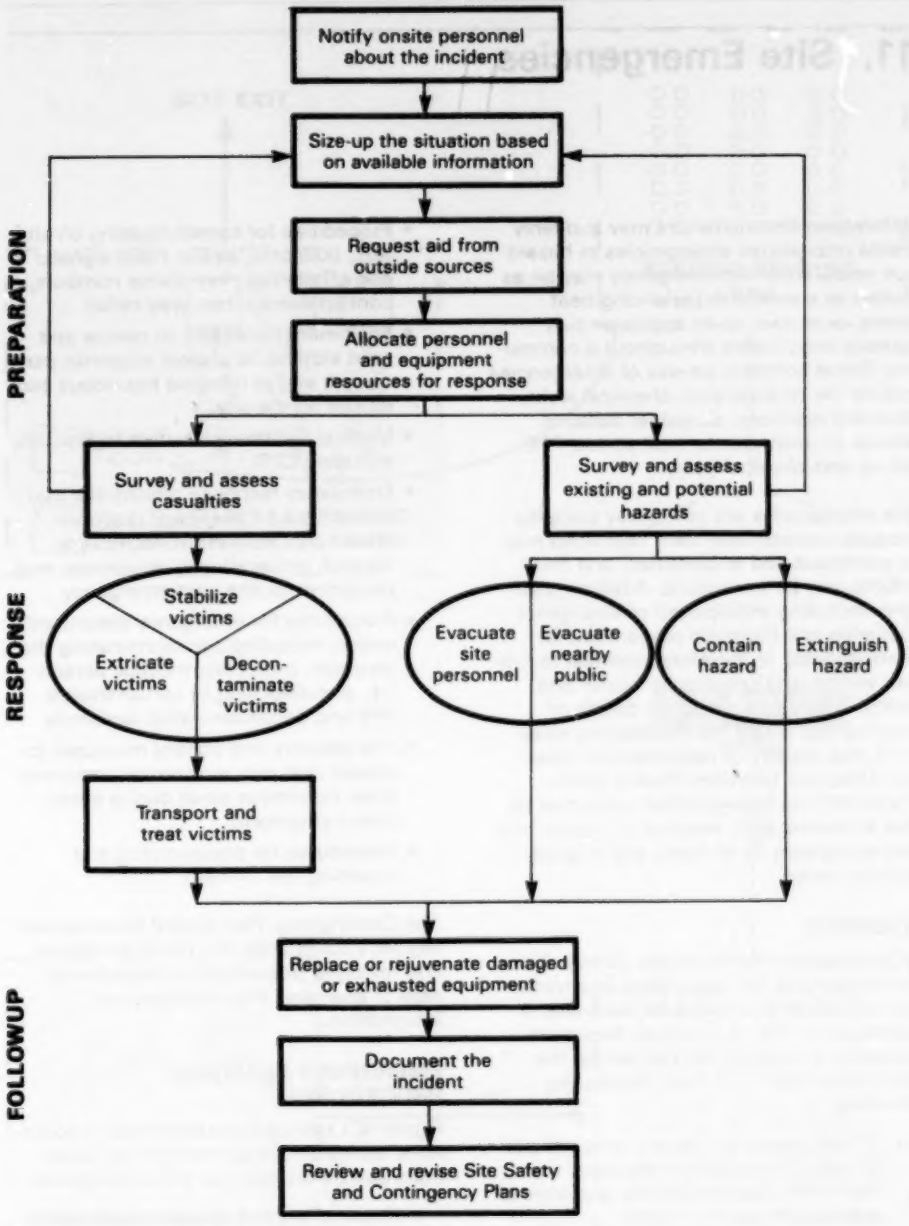


Figure 10. Emergency Response Operations.

- *Response*, which involves rescuing, decontaminating, and treating victims; evacuating personnel and/or the public as necessary; and controlling the hazard.
- *Followup*, which involves replacing equipment, documenting the incident, and reviewing and revising the Site Safety and Contingency Plans.

COMMUNICATIONS

In an emergency, crucial messages must be conveyed quickly and accurately. Site staff must be able to communicate information such as the location of injured personnel, orders to evacuate the site, and notice of blocked evacuation routes, even through noise and confusion. Onsite support services must be reached, help obtained, and measures for public notification taken, as necessary.

To do this, a separate internal emergency communication system should be developed. Such a system may consist of a network of radios or field telephones (for communicating with workers from a distance) augmented by alarms, sirens, whistles, colored flags, flares, and hand or whole-body movements. The primary system must have a backup (e.g., hand signals) for use if radio communications fail.

The telephone is the most common mechanism used to obtain emergency assistance from offsite sources or to inform officials about hazardous situations that may affect public or environmental safety. All personnel should be familiar with the procedure for contacting public emergency aid teams such as fire departments, ambulance units, and hospitals.

Site emergencies involving significant chemical releases should be coordinated with Federal response organizations by notifying the National Response Center (800-424-8802).

SITE SECURITY AND CONTROL

In an emergency, the Project Team Leader must know who is on site and must be able to control the entry of site personnel into the hazardous areas to prevent additional injury and exposure. Only necessary rescue and response personnel should be allowed into the Exclusion Zone. One control technique is a checkpoint or series of checkpoints through which all personnel entering or exiting the site must pass.

The Project Team Leader and reserve personnel must also be able to rapidly determine where workers are located and who may be injured. A passive locator system, such as a site map with flags or color-headed pins identifying each worker, is useful in helping to find personnel in an emergency. Active locator systems, such as personnel locator beacons that are worn by the worker and activated by the worker flipping a switch, can also be used.

EQUIPMENT

In an emergency, equipment is necessary to rescue and treat victims, to protect emergency response personnel, and to mitigate hazardous conditions on site (e.g., to fight fires or contain chemicals). All equipment should be in working order, fueled, and available when an emergency occurs. Basic equipment that should be available at any site is listed in Table 8. Special equipment should be obtained depending on the specific types of emergencies that may occur at a particular site and the capabilities of backup offsite personnel.

Table 8. Onsite Equipment and Supplies for Emergency Response

PERSONAL PROTECTION	MEDICAL	HAZARD MITIGATION
• Escape SCBA or SCBA, which can be brought to the victim to replace or supplement his or her SCBA • Personal protective equipment and clothing specialized for known site hazards	• Air splints • Antiseptics • Blankets • Decontamination solutions appropriate for onsite chemical hazards • Emergency eye wash • Emergency showers or wash stations • Ice • Reference books containing basic first-aid procedures and information on treatment of specific chemical injuries • Resuscitator • Safety harness • Stretchers • Water, in portable containers • Wire basket litter (Stokes litter) which can be used to carry a victim in bad weather and on a difficult terrain, allows easy decontamination of the victim, and is itself easy to decontaminate	• Fire-fighting equipment and supplies • Spill-containment equipment, such as absorbents and oil booms • Special hazardous-use tools such as remote pneumatic impact wrenches, non-sparking wrenches and picks • Containers to hold contaminated materials

EVACUATION

A severe emergency, such as a fire or explosion, may cut workers off from the normal site exit. Therefore, alternative routes for evacuating victims and endangered personnel should be established in advance, marked, and kept clear.

Safe distances for evacuation of personnel or the surrounding community due to the hazards posed by a hazardous substance release can only be determined at the time of an emergency, based on a combination of site- and incident-specific factors such as the quantity of substance released, the rate of release, and the wind speed and direction.

DECONTAMINATION

In some emergency situations, decontamination may be an essential part of life-saving first aid, while in other emergencies,

decontamination may aggravate the injury or delay life-saving efforts. The decision of whether or not to decontaminate a victim must be based on the type and severity of the illness or injury and the nature of the contaminants. If decontamination does not interfere with essential treatment, it should be performed. If decontamination cannot be performed, the victim should be wrapped in blankets, plastic, or rubber to reduce contamination of other personnel, and offsite emergency medical personnel should be alerted to the potential contamination (and to specific decontamination procedures, if necessary).

MEDICAL TREATMENT

In emergencies, medical treatment may range from bandaging of minor cuts and abrasions to life-saving techniques. In many cases, essential medical help may not be immediately available. For this reason, it is vital to train onsite emergency personnel in on-the-spot treatment techniques, to establish and maintain telephone contact with medical experts, and to establish liaisons with local hospitals and ambulance services.

FOLLOWUP

Immediately following a hazardous waste site emergency, the Project Team Leader should investigate and document the incident. This is especially important when the incident has resulted in personal injury, property damage, or damage to the surrounding environment.

Before normal site activities are resumed, government agencies should be notified as required, and personnel must be fully prepared and equipped to handle another emergency. Equipment should be repaired or replaced, and cleaned and refueled for future use. Supplies should be restocked.

The Site Safety and Contingency Plans should be reviewed and revised based on new site conditions and lessons learned from the emergency response.

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